SMALL BEACH EROSION CONTROL PROJECT

PLUM ISLAND BEACH
NEWBURY, MASSACHUSETTS

DETAILED PROJECT REPORT

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASSACHUSETTS 02154

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PLUM ISLAND, MASSACHUSETTS
TOWN OF NEWBURY, MASSACHUSETTS

1. Authority. This report was prepared under the small beach erosion control project authority of Section 103 of the 1962 River and Harbor Act, as amended.

2. Purpose. The purpose of this report is to determine the most economical and practical method of providing a protective and recreational beach as an emergency measure along a seriously eroding sector of the residential and commercial shorefront of Plum Island.

3. Prior Reports. A beach erosion control report for Plum Island was completed in 1952 by the Corps of Engineers in cooperation with the Commonwealth of Massachusetts and is published as House Document No. 243, 83d Congress, 2d Session. This report recommended no Federal participation in the cost of beach erosion control improvements for the overall Plum Island area because the shore was privately owned. It did, however, recommend that protective measures be undertaken by local interests in accordance with a plan developed in the Federal study; i.e., placement of about 285,000 cubic yards of suitable sand fill along the beach, and raising the shore end of the south jetty at the Merrimack River to 16 feet above mean low water. In addition to the 1952 study, a design memorandum on rehabilitation of the north and south jetties at the entrance to the Merrimack River completed in 1965, did result in the sealing and raising of the south jetty. The work was completed in 1969.

4. In 1967, a reconnaissance study was made pursuant to Section 103, Small Beach Erosion Control Authority, for the northerly Plum Island shorefront. It determined that the needed beach erosion control improvement project exceeded the $1,000,000 Federal expenditure limit. Therefore, officials of the state, City of Newburyport, and Town of Newbury were advised to seek a Congressional resolution to complete the study. It is understood that such action is currently being taken by Congressional representatives in the area.

5. In 1969, following a series of severe winter storms that caused extensive erosion along the south shore of the mouth of the Merrimack River, a special study was completed which recommended that a revetment be placed along the shore in the vicinity of the U. S. Coast Guard

Station to protect it from being lost, and to protect the Federal south jetty structure from being flanked. The work was done in 1970.

6. Description. The ocean shoreline of Plum Island is about 8 miles in length. Plum Island is a sandy coastal barrier bar largely covered with dunes along its southern two-thirds section. These dunes reach as high as 50 feet above mean sea level. The bar is separated from the Plum Island River to the west by a marsh which is generally greater in width than the bar. The bar varies in width between one-tenth and four-tenths of a mile, and averages one-fourth of a mile in the area south of "The Basin", a body of water extending southward from the Merrimack River Estuary. The bar at its narrowest point is about 350 feet wide. The maximum width is six-tenths of a mile at the Merrimack River. Residential and commercial development is concentrated at the northern portion of the island within the limits of the City of Newburyport and the Town of Newbury. The development includes cottages, churches, commercial establishments, and a U. S. Coast Guard Station. The remainder of the island to the south, with minor exceptions, is set aside as a Federal wildlife santuary operated by the U. S. Fish and Wildlife Service. Access to the island is furnished by the Plum Island Turnpike, which runs from the City of Newburyport to Northern Boulevard, the only surfaced road on Plum Island, leading to the north end development. The area under study is shown on U. S. Coast and Geodetic Survey Charts 213 and 1206, the Newburyport East Quadrangle of the U. S. Geological Survey, and drawings accompanying this report.

7. Statement of the Problem and Improvements Desired. The overall erosion problem is generally the same as that studied in the survey of 1952, i.e., erosion of the ocean shorefront seaward of the cottages with losses of fronting beach and protective dunes at various locations. The erosion has been particularly severe during major storms, and has resulted in losses of cottages, serious reduction in lot sizes, and total loss of some seaward lots. Many cottages have been moved landward as far as possible and are now bordering northern boulevard.

8. The major immediate problem, now constituting an emergency, is the erosion occurring along an 800-foot sector of shorefront at the termination of the Plum Island Turnpike and fronting Northern Boulevard. The near record storm of 19 February 1972 destroyed a wide fronting beach, backlying dunes, and one cottage. Serious damage also occurred to at least two other cottages, and two cottages have been

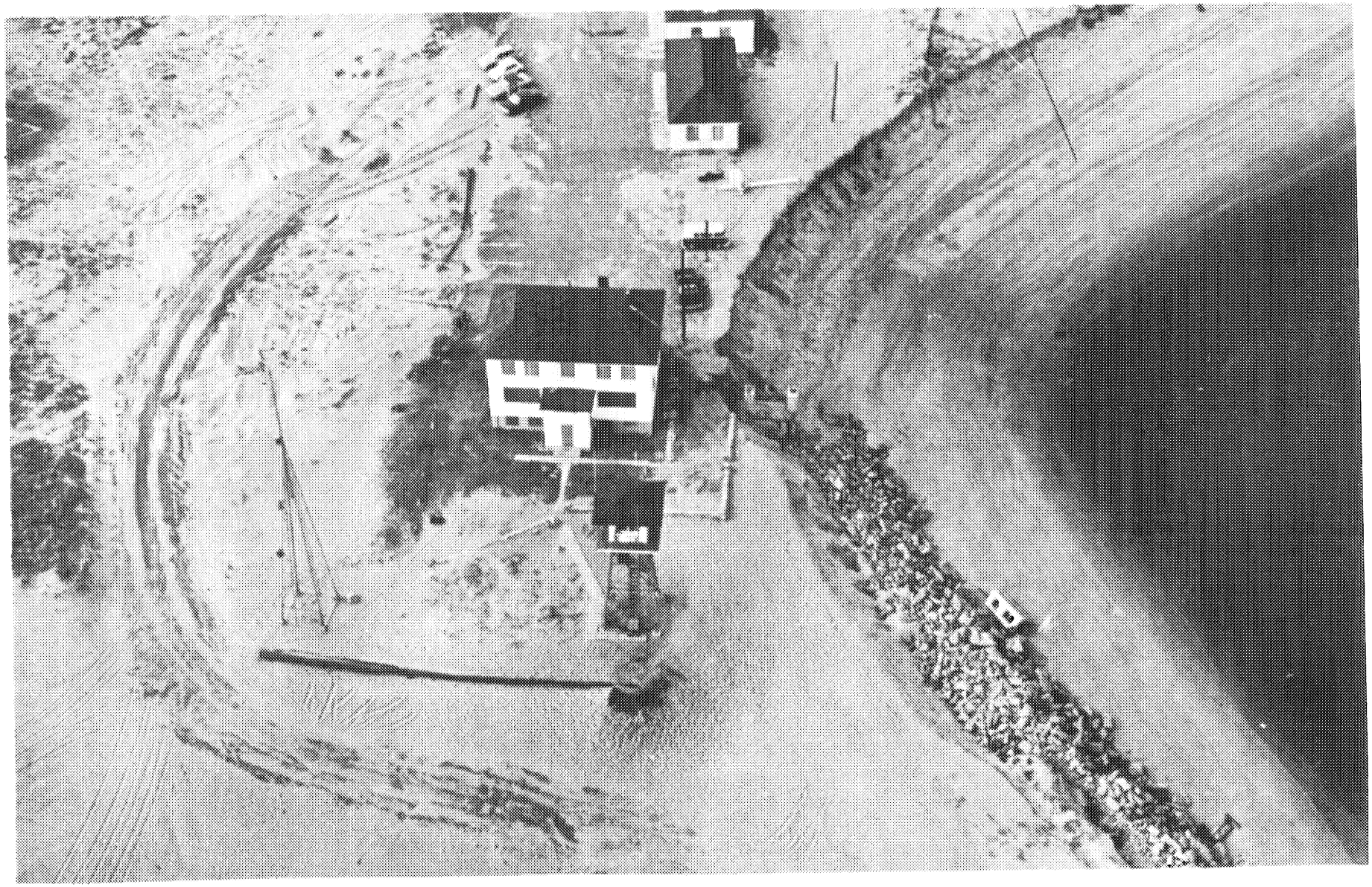


Photo 1. COAST GUARD STATION 1969. A series of winter storms experienced early in 1969 caused extensive erosion along the south shore of the mouth of the Merrimack River at the U.S. Coast Guard property.

Photo 2. PLUM ISLAND 1966. Looking northerly of Plum Island Turnpike groin along wide protective beach and dunes that existed prior to the 19 February 1972 storm.

Photo 3. PLUM ISLAND 1972. Looking north from turnpike groin after 19 February 1972 storm. Wide beach and protective dunes formerly fronting backshore homes were destroyed by storm.

Photo 4. PLUM ISLAND 1972. Loss of dunes and beach now places several cottages in immediate danger. Unravelling of remaining dunes to the north can now be expected, then, with far more extensive damage occurring.

moved inland to the maximum distance possible. With the destruction of the last line of natural defense (fronting beach and dunes) a major break through can now occur which would result in the destruction of eleven houses, overtopping of a sector of the Plum Island Turnpike and Northern Boulevard, general unravelling of the remaining protective dunes to the north, and flooding of at least 30 houses and commercial establishments. The cutting off of the boulevard would interrupt electrical service and isolate the northern sector of the island thus placing about 300 permanent residents in jeopardy during an emergency situation. This would occur frequently once the remaining dunes and embankment have been breached. The continued northerly unravelling of dunes will likely result in the eventual connection of the ocean to "The Basin" proper. A major breakthrough has been prevented to date due to timely flood fighting operations with technical assistance provided by the Corps of Engineers by the National Guard and local interests who have placed sand bags strategically along weakened embankment and dune areas during severe storms.

9. Many of the shorefront property owners along the area of erosion in question, have deeded over their seaward property to the Town of Newbury for public use and the town has obtained the remaining properties necessary, by eminent domain. Therefore, state and local interests strongly desire that an improvement project be developed to provide protection against further shore erosion, as well as to provide recreational salt water bathing needs.

It is emphasized here that the erosion problem under study in this report is only a relatively small sector of the overall shorefront area experiencing periodic erosion, i.e., the Plum Island shorefront from the south jetty southward to and including the area in question. Therefore, an overall study of the Plum Island ocean front is required in the interest of erosion control and recreational use. Such a study has to be authorized by Congressional Resolution calling for a review of House Document No. 243, 83rd Congress, since the improvements would undoubtedly exceed the Federal cost limitation under Section 103. Construction of an erosion control project in the southerly section now, is a necessary first step and a valued enhancement to the more comprehensive project as it will protect against further unravelling of the remaining natural dunes to the north and possible breaching.

FACTORS PERTINENT TO THE PROBLEM

10. Geomorphology. The shoreline of Plum Island is one of submergence of the land with respect to the level of the sea. Beach and dune

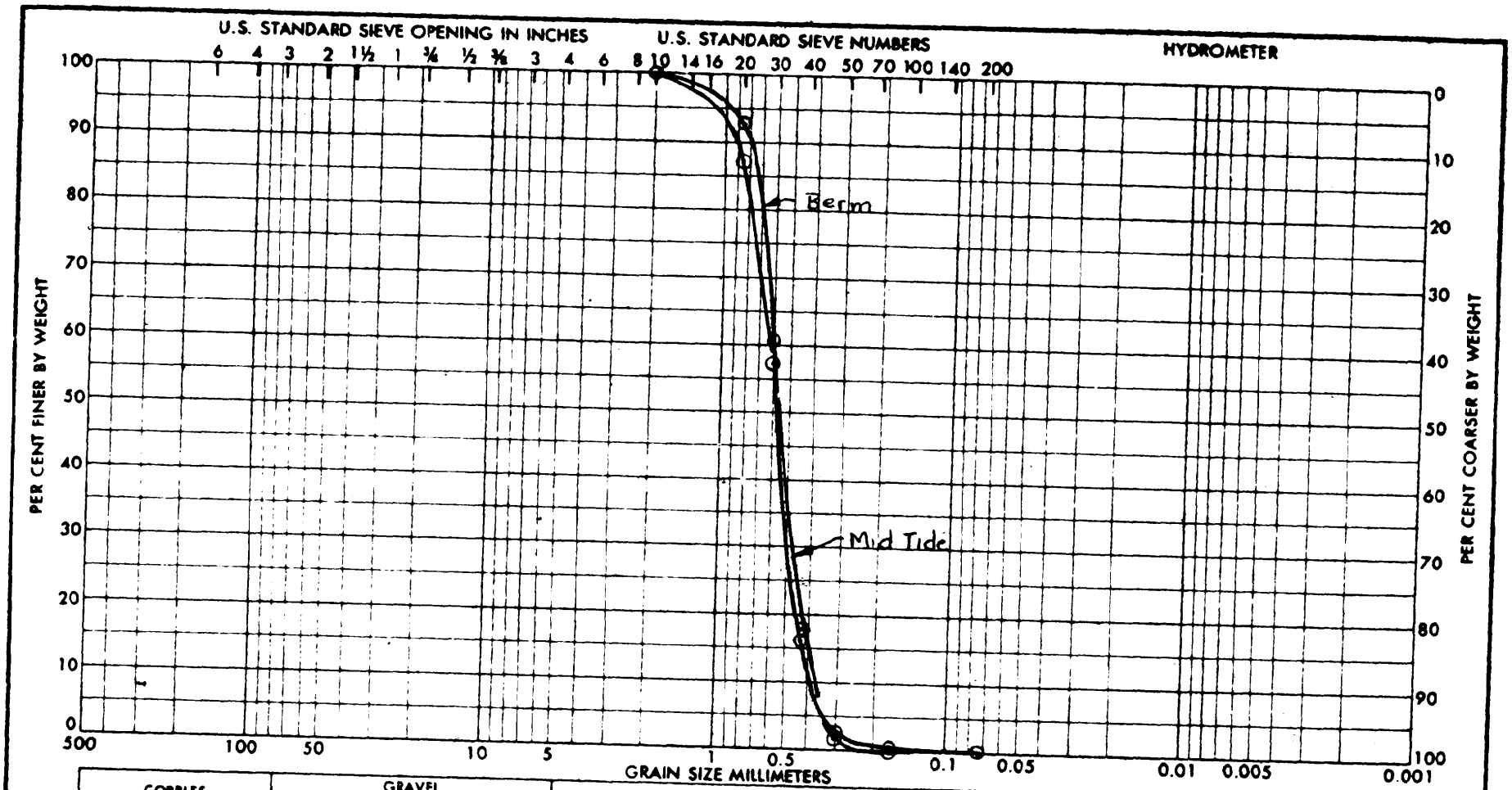
materials are glacial in origin as demonstrated by the existence of drumlin formations at the southeast tip of the island. The island has been shaped by a combination of tidal, wave, and wind produced processes, which have formed dunes as high as 50 feet.

11. Littoral Materials. (a) Characteristics - Visual inspection, information obtained from the prior study, and sampling along beach profiles, disclose that the beach material is generally of medium texture (see figure 1, typical gradation curve). Materials in the dune are a mixture of fine and medium sand. Samples taken at the mouth of the Merrimack River and offshore from the north end of Plum Island indicate that offshore material is coarser than the beach material. Median diameters of the material along the foreshore exceed 0.40 mm but are not greater than 2.0 mm, which constitutes stable beach building sand.

(b) Sources. Glacial deposits constitute the major source of beach materials. The drumlins and dunes along the southern shorefront are natural sources of materials and are subjected to severe erosion during storms when wave overtopping of the backshore occurs. Erosion of the unprotected dunes and embankment along the south shore of the mouth of the Merrimack River contribute to the beach building process and to material moving north and south during northeast and southeast storms, as demonstrated by the outer bar at the Merrimack River entrance and offshore of the shorefront.

12. Littoral Forces.

(a) Tides - The tides at Plum Island are semi-diurnal. The range of tide at the Merrimack River entrance at the north end of Plum Island is 8.3 feet and the spring range is 9.5 feet. The mean range of tide at the mouth of the Ipswich River at the south end of Plum Island is 8.6 feet and the spring range is 9.9 feet. Studies indicate that tides exceed the plane of mean high water by 2 feet or more once a year and by 3 feet or more once every two years. In 1944 and 1959, storm tides of 3.9 feet above mean high water were experienced at Seavey Island at Portsmouth, New Hampshire, which is located about 17 miles northerly of the study area. The record storm of 19 February 1972 produced a tide of 4.4 feet above mean high water at Seavey Island.



SAMPLE NO.	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
P-3	Berm	m-f SAND (SP)				
P-3	Mid Tide	m-f SAND (SP)				

GRADATION CURVES

PROJECT Plum Island Beach

TYPICAL GRADATION CURVE

DATE Aug 1968

ENG FORM 2087
1 MAY 63

REPLACES WES FORM NO. 1241, SEP 1962, WHICH IS OBSOLETE.

U. S. GOVERNMENT PRINTING OFFICE 1963 OF—700—128

FIGURE 1.

(b) Waves - Wave hindcast studies, based on data obtained at the Penobscot Bay Station, Maine and the Nauset Beach Station, Cape Cod, Massachusetts (outlined in Beach Erosion Board Technical Memorandum 55), indicate that the maximum waves occur from the east-northeast and east. Over 25 percent of the time the waves are from the eastnortheast. Just under 25 percent of the time, the waves are from the east. At least 5 percent of the time, waves approach from the east-southeast. Some small degree of protection from northeast storm waves is afforded by the Isle of Shoals lying 15 miles northeast of the Merrimack River entrance. Cape Ann to the south provides some protection from southeast storm waves.

(c) Currents - An inspection of the 1973 tide tables, published by the U. S. Department of Commerce, National Oceanic and Atmospheric Administration, show that the maximum currents at the Merrimack River entrance do not exceed 2.2 knots. Other than the effects on sand movement in and out of the channel entrance and distribution and shaping of the outer bar, these currents do not contribute to the erosion problem 6,000 feet to the south.

(d) Winds - A wind rose completed from a 10 year wind record for Logan Airport, Boston, Massachusetts, shows that the prevailing winds blow offshore from western quadrants. Winds blowing onshore across the Gulf of Maine from the northeast and southeast guadrants, produce the damaging waves.

(e) Storms - A study of records of the United States Weather Bureau at Boston, Massachusetts, shows that the preponderance of gales (winds greater than 39 miles per hour) blow from the northeasterly direction. These storms are usually of long duration extending through several high tides and result in erosion of beach and backshore areas with undermining and damage to or losses of structures and cottages.

13. Shore History.

(a) Shoreline Changes. The greatest shoreline changes have occurred at the northern portion of Plum Island at the entrance to the Merrimack River. Historically, these changes occurred prior to the construction of the jetties. In 1827, the mouth of the Merrimack River was located about one-half mile south of its present position. "The Basin" did not exist at that time. The southerly ocean bar migrated

northwesterly forming the ocean shorefront and "Basin" during the period 1827 to 1851. With construction of the jetties around the turn of the century, substantial accretion occurred forming the ocean front shores of the island. Surveys made by the U. S. Coast and Geodetic Survey (now called National Ocean Survey) and by the Commonwealth of Massachusetts, reveal that between 1928 and 1952 a continuous recession occurred along the shore located 3,400 feet to 11,000 feet south of the south jetty. This recession was estimated at 150 feet opposite the south end of "The Basin" 250 feet midway between "The Basin" and the seaward end of the Plum Island Turnpike, 100 feet at Plum Island Turnpike, 150 feet fronting cottages south of the turnpike, and 200 feet along 2,000 feet of shore south of the cottages. Comparative surveys made in the problem area in 1968 and 1972, show the shoreline receded an average of 6 feet a year within the Plum Island Turnpike area.

(b) Prior Corrective Action and Existing Structures. At the time of the beach erosion control study of 1952, there were no significant structures built solely for beach erosion control. However, in 1953, the Commonwealth of Massachusetts placed about 560,000 cubic yards of sandfill along the beach starting at the Plum Island Turnpike and extending in a northerly direction for a distance of 3,000 feet. This was done generally in accord with recommendations made in the 1952 Federal study. The sand was pumped from "The Basin" and was quite fine. Between 1954 and 1964, the Commonwealth constructed five groin structures along this northerly developed area. In 1966, it constructed stone revetment along embankments at various locations of the beach lying between 1,500 feet to 4,500 feet north of the Plum Island Turnpike. Private property owners have constructed bulkheads or revetment from time to time along the eroding embankment fronting their properties. Other than the groin structures, there have been no artificial structures along the natural dunes and the fronting beach.

(c) Beach Profiles and Volumetric Changes. Beach profiles for the problem areas, as shown on plate 3 were completed by the Corps of Engineers in 1968 and 1972. Generally, the seaward face of the profile within the surf zone area is comparatively steep, averaging 1 vertical on 10 horizontal. The net change since the 1952 study has been one of erosion even with the added artificial fill placed by the Commonwealth in 1953. Much of the erosion within the problem area is believed to have occurred during the 19 February 1972 storm based on field observations of this area since 1968. The total estimated amount of erosion within the surf zone based on volumetric computations for the 1968-1971 profiles averages about 3,000 cubic yards a year.

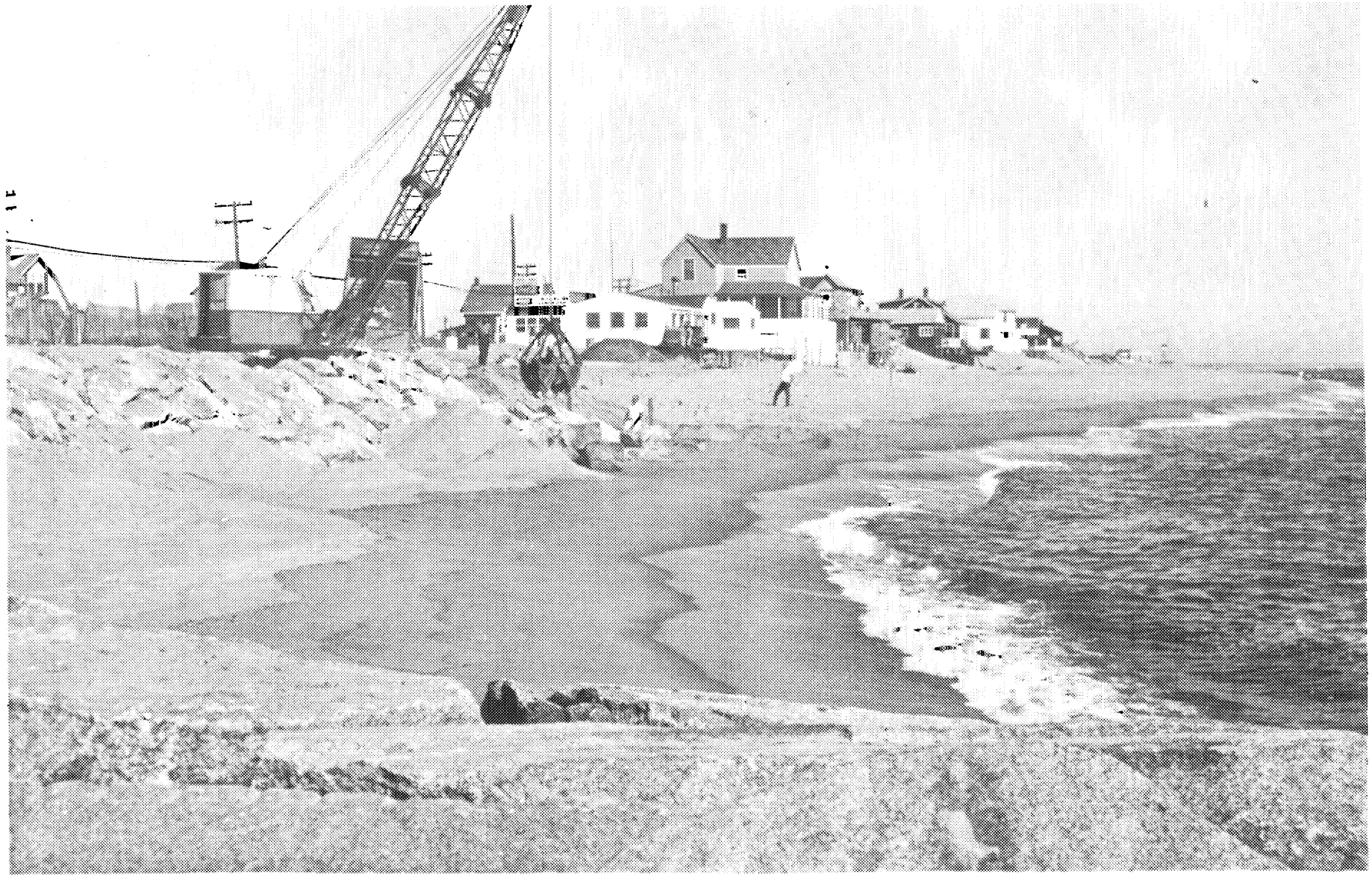


Photo 5. PLUM ISLAND 1966. In 1966, problem area existed along about 3000 foot sector extending north of groin number 2. State constructed a section of revetment here and at other sporadic locations to the north.

ANALYSIS OF THE PROBLEM

14. Shore Processes Pertinent to the Problem. The geological structure of the 8-mile long barrier beach section contained between the Merrimack River on the north and the Ipswich River on the south, lends itself to a constant movement of material. It is a naturally formed, unprotected shorefront except for the northerly developed sector where some protection has been added. Therefore, substantial amounts of sand within this isolated sector is available for transmission through wave action, and is supplemented by sand moving in from offshore sources. The overall area, including the inner estuary of the Merrimack River and the oceanfront, is an interdependent system involving seasonal changes, with changes in one area affecting other sectors of the shorefront. Studies have determined that the changing offshore bar configuration plays a major role in the erosion or accretion of the backshore.

In 1966, the most seriously eroding sector was along a 3,000 foot sector starting 1,500 feet north of the Plum Island Turnpike. Based on hydrography surveys made in 1968, refraction analyses for 8 second storm driven waves approaching from the east-northeast, east, and east-southeast were made. These analyses determined that in general the east and east-northeast waves were turned northerly from the area of the Plum Island Turnpike. However, there was a concentration of wave energy directed to the then eroding sector to the north, as heretofore described, causing substantial offshore losses. In 1969, a series of winter storms occurred during a period of neap tides and caused very serious erosion of the south shore of the mouth of the Merrimack River when about 1,000,000 cubic yards of material moved into the channel, and then was carried out of the harbor and deposited along the outer ocean front bar. Immediately following the storm, the sand could be observed as exposed shoals on the outer bar deposited as offshore promontories at the northerly sector of the island. A large volume of sand was then deposited along the shore to the north of the Plum Island Turnpike. Soon after, however, field observations showed that the erosion had shifted southerly to the Plum Island Turnpike area. This resulted from the major changes that occurred along the offshore bar profile with wave refraction resulting in a lensing of waves and convergence of energy along this sector of shore, while diverging waves and subsequent flattening of waves occurred to the north with a resultant beach build-up in the formerly eroding northerly sector. The record storm of 19 February 1972 continued this type of wave directed energy with major offshore losses occurring along the area in the vicinity of Plum Island Turnpike. This action resulted in loss of fronting beach backshore dunes and substantial loss of the backshore dunes and embankment.

PLAN FORMULATION

15. General. There are several alternative methods of correcting the problem. However, a solution which is both practical and economically feasible must be utilized. The completed beach erosion study of Plum Island in 1952 considered many alternative solutions including offshore breakwaters, revetments, bulkheading, groin structures and beach widening. It was determined that for groin structures to be effective to build up the beach in the overall problem area, they would need to extend seaward to the outer bar to intercept material moving along the bar predominantly from the northeast during storms generally from that direction. Shorter groins might be effective to some degree in retarding losses from the beach. Although bulkheading or revetment might be effective to protect the backshore, these structures would not hold the fronting beach. Offshore breakwaters could be effective for erosion control but are extremely costly. The most practical and economically feasible method, furnishing both erosion control and beach restoration, is by dune and embankment restoration, i.e., providing a protective and recreational beach within the problem area by direct placement of suitable sand fill with the required periodic nourishment to assure its effectiveness during the lifetime of the project. This protection is only a portion of what is needed for the entire northerly developed sector of Plum Island; however, this method of improvement is required as an emergency measure within the narrow and weak portion of Plum Island, now widely utilized for recreational salt water bathing purposes and upon which the safety and well being of the development depend on its continued strength against breaching by damaging storm driven waves.

16. Design Criteria. The proposed method of protection is designed to furnish emergency protection along a crucially eroding sector of the ocean exposure of Plum Island from the more frequent storms. Although it will not afford complete protection from the infrequent higher level storms, nevertheless, it will provide a substantial degree of protection under such conditions. Pertinent design criteria is described below:

(a) Design Tide. A design tide of 12 feet above mean low water is considered as the practical elevation for this area. This represents a tide level approaching 4 feet above mean high water. A tide level of 4 feet above mean high water might be expected to occur about once in 20 years although tides reach 3 feet or more above mean high water as frequently as once in two years.

(b) Design Wave. Hindcast studies of deepwater waves indicate a 15 foot, 8 second wave is representative of most frequent storms. Storm driven waves from the east-northeast and east occur with the greatest frequent with storm waves from the southeast probably not exceeding 5 percent of the time. The design wave breaking on the face of the beach within the surf zone, allowing for about 4 feet of erosion, is estimated at about 6 feet based on a depth factor of 0.78 "D" as the maximum wave that can be supported where "D" is the water depth for the design storm tide.

PLAN OF PROTECTION

17. The plan of improvement consists of dune restoration and embankment reinforcing along 800 feet of backshore fronted by a protective beach formed by direct placement of suitable sandfill furnishing a level beach berm of 75.0 feet in width at an elevation of 15.0 feet above mean low water, thence extending seaward on a slope of 1 vertical on 10 horizontal. The top elevation of the dune is 24.0 feet above mean low water with a seaward slope of 1 vertical on 5 horizontal with the same landward slope where required. The top elevation of the dune is equivelent to the general natural embankment and stable dune elevations in this area. The construction will form a protective width of about 210 feet in front of the existing backshore. See plate 5 for details of the plan of protection.

ESTIMATE OF FIRST COST

18. The first cost is based on price levels prevailing in January 1973 and on the following method of construction: pumping sand hyraulically from the Merrimack River navigation channel to some intermediate stockpile area along the ocean front; thence, by truck to the erosion site. There is an abundance of suitable sand in the estuary. The quantity of sandfill required was based on hydrographic and topographic surveys completed in January 1973. An itemized first cost of construction for the plan of improvement is tabulated below:

ITEM	QUANTITY ESTIMATED	UNIT COST	ESTIMATED AMOUNT
Sandfill			
Dune & Embankment Restoration	4,000 c.y. @	$5.00	$ 20,000
Beach Widening	31,000 c.y. @	$5.00	$155,000
	Sub Total		$175,000
	Contingencies		6,000
	Sub Total		$181,000
	Engineering & Design		4,000
	Sub Total		$185,000
	Supervision & Administration		15,000
	TOTAL FIRST COST		$200,000

ESTIMATE OF ANNUAL CHARGES

19. The Federal and non-Federal charges are computed at the rate of 5 1/2 percent. A project life of 50 years is used for amortization purposes. The annual charges for periodic nourishment are based on losses within the surf zone area experienced during the 3 year interval between the 1968 and 1972 hydrographic surveys. However, this has been adjusted to reflect the more serious condition that now exists, i.e., the loss of the fronting dunes that formerly contributed to the natural nourishment processes that were experienced during the overall cyclic erosion and accretion occurrences for the area. Therefore, the required annual periodic nourishment is estimated at 3,000 cubic yards. The total annual charges are tabulated below:

ANNUAL CHARGES

Federal Investment

Interest (0.055 x $100,000)	$ 5,550
Amortization (.00406 x $100,000)	400
Periodic beach nourishment, 1500 cy @ $5.00	7,500
TOTAL FEDERAL ANNUAL CHARGES	$ 13,400

Non-Federal Investment

Interest (0.055 x $100,000)	$ 5,500
Amortization (.00406 x $100,000)	400
Periodic Nourishment, 1,500 cy @ $5.00	7,500
TOTAL NON-FEDERAL ANNUAL CHARGES	$13,400

TOTAL ANNUAL CHARGES $ 26,800

APPORTIONMENT OF COSTS

20. The cost apportionment is based on policy set forth in Public Law 826, 84th Congress, as amended and supplemented by Public Law 87-874 of the River and Harbor Act of 23 October 1962, as amended. Under these laws, Federal participation in the cost of construction of protective work along publicly owned shores is authorized up to one-half of the cost except in cases involving parks and conservation areas meeting certain Federal criteria, in which Federal share can be 70%. The Plum Island erosion problem under study qualifies for 50% Federal participation. Total Federal expenditures under this small beach erosion control project program of Section 103 cannot exceed $1,000,000, including the Federal share of periodic beach nourishment for ten years. Privately owned shores are eligible for Federal aid if there is a benefit such as that arising from public use or from the protection of nearby public property, or if the benefits to the shores are incidental to the project and the Federal contributions to the project are adjusted in accordance with the degree of such benefits. The fronting shorefront within the project area has now been converted to public ownership by deeding the affected properties over to the Town of Newbury. Local interests will be required to provide public access and necessary parking facilities during the lifetime of the project.

ESTIMATE OF BENEFITS

21. General. The primary benefits attributed to the improvement and computed herein are based on (1) the reduction in the cost of maintenance of highways and backshore structures and repair of parking areas frequently required after serious storms, (2) prevention of direct damages by preventing loss of land, and (3) the encouragement of healthful recreation by the populace by protection and improvement of the dry beach area. The intangible benefit of increasing the desirability of the beach area and, therefore, increasing the pleasure

derived therefrom and general overall enhancement of the area, particularly in the increased monetary revenues resulting from expanded use of the area and rise in property real estate, is not evaluated. The United States does not own land in the project area involved. Therefore, no Federal benefit will result from the plan considered. Recreational benefits are evaluated as general and local public benefits. Benefits derived from the prevention of loss of land are evaluated as private and public benefits.

22. Reduction of Maintenance and Repair Cost. Damages prevented at Plum Island are in the form of reduction in costs of clearance of debris and wreckage, repair or replacement of roads, streets and highway facilities, and repair or replacement of dikes, levees and drainage facilities required after severe storms. Precise figures over the years from the Town of Newbury were not available. Available figures from the Massachusetts Civil Defense Agency, however, indicate annual emergency expenditures of approximately $10,000 per year at Plum Island. For the project area itself, it is estimated that these costs are about $2,000 per year.

23. Prevention of Loss of Land. The proposed improvement will prevent loss of privately and publicly owned land which has been occurring for many years. Land in most immediate danger of eroding is that just east of Northern Boulevard extending approximately 800 feet northerly along the shorefront beginning at the Plum Island Turnpike Road groin. It is this area where several homes have already been either lost or moved back closer to the road and where the threat of serious breaching now exists which would endanger low-lying lots further inland. Local sources indicate that such breaching along with interior flooding now occurs during severe storms and abnormally high tides. Other points of possible breaching have also been identified further north along the Boulevard. In absence of the proposed project, it is anticipated that the annual loss of land cause by erosion will be 1,440 square feet. Valued at $1.30 per square foot, the annual loss is expected to be approximately $1,900.

24. Recreation. Plum Island beach, located on Massachusetts recreation oriented "North Shore", caters basically to local Essex County residents and the overflow from the area's more popular and better equipped private, municipal, state and federal swimming facilities. In essence, it is the lack of public use facilities and dwindling supply of

beach caused by erosion which prevents this beach from becoming one of the most popular areas on the "North Shore" and the main destination of bathers rather than an alternative.

25. Looking at the supply of swimming facilities in eastern Massachussetts, the Atlantic Ocean is the major water resource and although the coastal strip is richly endowed with hundreds of miles of irregular and indented coastline which provide many sheltered and sandy beaches, the increasingly intensive use of these water areas has created problems. In general, the major problems are a lack of public access and polluted waters which have limited the use of many water areas. At Plum Island, the particular problem of erosion has contributed to the underutilization of this resource. Coinciding with shrinking supply, expanding population and rising personal income coupled with general trends toward more leisure time and greater mobility, have increased the pressure on the recreational demand-supply relationship. The population of Essex County alone expanded from 568,800 persons in 1960, to 637,900 in 1970, or an increase of 12 percent.

26. In preparation of the "Massachusetts Outdoor Recreation Plan" to be released in early 1973, the Division of Conservation Services within the State Department of Natural Resources researched the 1970 demand-supply relationship of swimming facilities for the Eastern Massachusetts Planning Region and determined needs. In 1970, the population of Massachusetts, one of the most urban states in the nation, was 5,689,200. Of this 3,769,400 persons or approximately 66 percent were concentrated in the eastern part of the state as defined by the Eastern Massachusetts Planning Region which is centered in the City of Boston. In terms of annual activity days, swimming facilities showed the large deficit of all major recreation activities, with about three times as many facilities needed as were currently available. (An activity day is defined as one person participating in a given activity for part or all of one day). In actual figures, the need for swimming facilities in the Eastern Massachusetts Planning Region for 1970 amounted to about 62 million annual activity days. The state planners projected current supply at a rate corresponding to current program levels and determined that unmet swimming needs would increase greatly in the future. On a statewide basis, it was found that the need for swimming facilities would nearly double by the year 2000. The implication is strong that existing public and private programs providing swimming will have to be greatly increased if these needs are to be met. Documentation of the demand-supply relationship for Plum Island beach in terms of "with- and-without" the proposed project is set forth in the following paragraphs.

27. Recreation Demand. The beach space demand is determined from a composite of the demand from summer residents, transient tourists and day-trippers. The demand for beach space for each of these components is set forth below.

28. Beach Space Demand of Summer Residents. The summer population of Plum Island consists of the permanent year-round resident population and the local seasonal increase. The seasonal increase consists primarily of summer vacationing families in which the head of the household commutes daily or weekly to his normal place of employment and also of summer residents who derive their income from tourist services at Plum Island. In absolute numbers, the 1970 population in the Newbury portion of Plum Island increased from a permanent year-round level of 500 persons to an estimated 5,000 persons during the summer. Of the estimated 4,500 person seasonal increase, 30 percent or 1,350 are estimated to be seasonal residents and 70 percent or 3,150 persons to be transient tourists - those renting cottages for a one or two week vacation. Thus, a total of 1,850 persons are seasonal residents and of this amount, 30 percent or 555 are estimated to live in the immediate project area. Considering the composite of seasonal residents, it is estimated that average beach attendance on peak days constitute 70 percent of the populace and 50 percent on week days. Thus, roughly 400 people desire beach space on peak use days and 290 desire beach space on week days.

29. Beach Space Demand of Transient Tourists. As indicated above, approximately 3,150 transient tourists reside in the Newbury portion of Plum Island in the summer months. Of this, 30 percent or 945 people are estimated to be concentrated in the immediate project area. Recognizing that these tourists are renting cottages for an average two-week stay primarily for swimming, it is estimated that 75 percent or approximately 710 transient tourists desire beach space on both peak days and week days in the project area.

30. Beach Space Demand of Day-Trippers. Estimating the number of day-trippers to Plum Island proves difficult, for there is a lack of statistical data for the entire island. The only reliable data is from the Parker Wildlife Refuge which estimates an annual attendance of approximately 375,000 persons. It should be noted that the reservation must often be closed to the public on peak days at around 11:30 am due to a lack of parking spaces. Local sources indicate that traffic increases heavily when this occurs as the overflow filters out to other

parts of the island. An over-simplified method for estimating day-trippers is to determine the available parking facilities in the immediate project area and their occupancy rates. Field investigations indicate public parking facilities for at least 140 cars. Local sources indicate that on peak days, all 170 spaces are continuously filled with a heavy turnover, estimated to average two per space. On week days, at least 60 percent or 103 of these spaces are estimated to be continously occupied. Assuming an average of 4.5 persons per car, it is estimated that 1,530 day-trippers desire beach space on peak days and 920 on week days. To these totals must be added so-called "drop-offs" from the mainland. It is estimated that there are 500 persons on peak days and 300 on week days in the category resulting in a total of 2,030 and 1,220 day-trippers on peak days and week days, respectively.

31. Total Beach Space Demand. A summary of the composite of summer resident, transient tourist and day-tripper demand for beach space is as follows:

Week day attendance	2,210
Residents	280
Transients	710
Day-trippers	1,220
Peak Day Attendance	3,140
Residents	400
Transients	710
Day-trippers	2,030

32. Recreation Supply. Erosion is a natural and general condition that exists throughout the Plum Island area. At present, there are about 72,000 square feet of dry beach above the mean high tide line. By the year 2020, it is projected that erosion will have reduced the area of dry beach available at mean high tide to zero. In terms of capacity, based on a beach use area of 75 square feet per bather with a turnover of two, the project area can now handle approximately 1,920 persons per day which will in fifty years be reduced to none.

33. The proposed project would provide an additional dry beach area of 40,000 square feet or an additional capacity of 1,066 persons.

Added to the existing capacity, a total of 2,986 persons would be provided beach space under "with-the-project" conditions. Thus, the proposed project would satisfy week day demand and fall slightly short of satisfying peak day demand.

34. Recreation Benefits. The recreation benefits for Plum Island are predicated on a bathing season extending from mid-June to the 1st of September. Allowing for 25 percent inclement weather, there are an estimated 18 peak use bathing days and 40 week days of bathing use. A beach use area of 75 square feet per bather, with a turnover of two, is used as the maximum degree of usage. A reasonable per capita recreational value of a fully developed, public-use beach, with an adequate parking area and sufficent sanitary and bathhouse facilities with no over-crowding, is $1,25 per visit. For an incompletely developed public-use beach such as Plum Island, having minimum basic facilities, but where the general public will always have free and easy access to the beach, an average value of $0.85 is considered appropriate.

35. Recreation benefits are determined under "with-and-without" the project conditions and are shown below:

GROSS RECREATION BENEFITS:

Peak day demand satisfied	2.986 x 18x $.85 =	$ 45,686
Week day demand satisfied	2.210 x 40x $.85 -	75,140
		$120,826
	SAY	$120,800

EXISTING RECREATION BENEFITS:

Peak day	38.4 x 601.221 x .059 x 18 x .85 =	$20,841
Week day	38.4 x 601.221 x .059 x 40 x .85 =	46,312
		$77,153
	SAY	$77,200

NET RECREATION BENEFITS $43,673 SAY $43,700

36. Total Project Benefits.

Reduction of Maintenance and Repair Costs	$ 2,000
Prevention of Loss of Land	1,900
Recreation	43,700
	$47,600

37. In addition to the foregoing primary benefits, there will, of course, be very strong intangible benefits as a result of prevention of extensive potential losses to properties if the barrier beach is breached. Even more important would be the elimination of the potential hazard to the health and safety of the local residents.

38. Maximization of Net Benefits.

ANNUAL COST	ANNUAL BENEFITS	BCR	EXCESS BENEFITS
$26,800	$47,600	1.8	$20,800

ENVIRONMENTAL IMPACT

39. The proposed improvement involves taking relatively unpolluted sand from the Merrimack River estuary and placing it directly on the beach in the area of critical erosion. No adverse effect on the environment in either area is expected to occur. The need to correct the erosion is immediate. Therefore, construction is scheduled to start the beginning of February 1973. This time of year for dredging and for depositing materials on the beach is probably the best from the point of view of least detriment to fisheries, etc., i.e. as opposed to spring and summer seasons. It is also pointed out that if nothing is done and a breach does occur, the impact on the environment could be extensive and severe.

COORDINATION WITH OTHER AGENCIES AND LOCAL INTERESTS

40. Because of the pressing need for solution to the erosion problem understudy, and the intense interest shown on the matter by U. S. and state senators and representatives, very close and constant coordination and cooperation has been maintained with all affected and interested parties. See Appendix A for pertinent correspondence. A waiver on holding a public meeting is requested because of numerous past meetings with local interests and the extensive publicity this erosion problem has received over the last several years.

CONCLUSIONS

41. It is concluded that the 800 foot long reach of ocean shorefront of Plum Island in the vicinity of the Plum Island Turnpike, has been severely eroded by storm waves in recent years, particularly during

the winter of 1972. This sector of shorefront is now in a state of critical erosion. That is, another severe northeasterly or easterly storm could result in breaching the Plum Island barrier beach at this point thus cutting off the development area of Plum Island from the mainland. Extensive losses to properties could result as well as a threat to the safety and well being of the residents. A beach erosion control improvement measure is needed immediately to assure against this occurring.

RECOMMENDATIONS

42. Therefore, the Division Engineer recommends approval of a beach erosion control project by the Chief of Engineers under the provisions of Section 103 of the River and Harbor Act of 1962 as amended. The project would provide for restoring the dune, strengthening the embankment, and widening the beach by direct placement of suitable sandfill for 800 feet of now publicly-owned beach (as a result of recent deeding over of privately-owned beach for public use), thus furnishing a protective and recreational improvement project with a top of dune elevation of 24.0 feet above mean low water, and a beach berm 75 feet wide at an elevation 15.0 feet (mlw) extending from the Plum Island Turnpike groin north for 420 feet, berm then varying in width for the remaining northern 380 feet to blend into existing ground at elevation 15.0. The estimated first cost of the project is $200,000 to be borne equally by the Federal Government and non-Federal interests. The Commonwealth of Massachusetts has already indicated a willingness and ability to provide the necessary non-Federal cash contribution of $100,000. The benefit-cost ratio is 1.8.

43. The Divsion Engineer further recommends that Federal participation be authorized in the amount of 50 percent of the cost of periodic nourishment by depositing sand on the beach at suitable intervals of time for the first 10 years of project life; the periodic nourishment to be by the United States after receipt of the local share of the cost.

44. Federal participation in the proposed project is subject to the condition that local interests will:

(a) Provide 50% of the project cost, presently estimated at $200,000 which includes cost for all investigations, planning, design, supervision, or administration involved in the development and construction of the project, including Federal costs for periodic nourishment.

(b) Assure continued public ownership or continued public use of the shore upon which the amount of Federal participation is based and its administration for public use during the economic life of the project.

(c) Assure maintenance and repair during the economic life of the project as many be required to serve the intended purpose, with Federal assistance in the amount of 50% on periodic beach nourishment.

(d) Provide at their own expense all necessary lands, easements, and rights-of-way.

(e) Hold and save the United States free from claims for damages that may result from construction and maintenance of the improvement.

(f) Assure that water pollution that would endanger the health of the bathers will not be permitted.

(g) Provide necessary parking and sanitary facilities, open to all on equal terms.

(h) Bear all project costs in excess of the Federal cost limitation of $1,000,000.

CHARLES J. OSTERNDORF
Colonel, Corps of Engineers
Acting Division Engineer

2 Incls
1. Appendix A - Pertinent correspondence
2. Maps (5)

APPENDIX A

Press Release by Mass. Governor Francis Sargent on Friday, 12 January 1973, at 1500 hours.

Governor Francis W. Sargent today announced that $100,000 from the state's emergency fund is to be used to prevent further erosion and property damage on Plum Island. A matching $100,000 is coming from the federal government.

"In recent months," the governor explained, "storms have severely eroded a section on Plum Island endangering several cottages, homes and a restaurant. The dune line is now so thin that with any further damage the ocean could easily break through, inundating several business properties. In addition, a severe storm could cut off the only road running the length of the island, as it is presently only three feet above normal high tide."

The funds will be used to enlarge and reshape sand dunes at a critical point along the beach. The initial construction is to be followed by a lengthy and complete study of the island's entire 11 mile beach situation by the U. S. Army Corps of Engineers.

Bids for the initial construction will go out January 26 - with completion expected by the end of February. Completion of the study of the island should take five years.

-30-

APPENDIX A

IMMEDIATE RELEASE - WEDNESDAY, DECEMBER 13, 1972

EMERGENCY AID FOUND FOR PLUM ISLAND

U. S. Representative Michael J. Harrington (D.-Mass.), U. S. Senators Edward M. Kennedy and Edward W. Brooke today announced that emergency assistance has been found for Plum Island. The Island, which has a history of severe flooding and erosion, was almost cut-off from the mainland during a Northeast storm in October.

According to Harrington, a law never before applied in the New England region will be utilized to build up the beach to prevent further erosion. This temporary solution will protect the Island from storm damage pending construction of a permanent facility. It is estimated that the permanent facility will not be ready for about 3 years.

"The law we discovered," said Harrington, "allows the Corps of Engineers to rebuild the beach with 50 per cent Federal and 50 per cent state funding. The total cost is estimated to be between $200,000 and $250,000."

The Bay State legislators had been turned down earlier by the Corps, the Small Business Administration, and the Office of Emergency Preparedness, because the commonly applied statutes fail to recognize the emergency nature of the Plum Island situation.

"The Corps will immediately formalize its plans once the beach property is made public and the state guarantees its share of the funding," said Senator Kennedy.

"We have been assured," said Senator Brooke, "that the land will be made public immediately, and the Governor's office is working to find the state's share of the funding."

Harrington said that all local officials including Senator William Saltonstall, Mayor Byron Matthews of Newburyport, Richard Knight, Chairman of the Newbury Board of Selectmen, Henry Walker, State Representative-Elect and Governor Sargent's office have been notified and that all are delighted with the solution.

"All the local officials have promised to provide every assistance possible," said Harrington. "The Governor's office has informed us it is optimistic that State funding will be guaranteed in the near future."

"We are confident," said Kennedy, "that with the high degree of cooperation evidenced on all sides, this temporary project can be built within the next three months."

Brooke said that the emergency assistance was essential, but noted that "a permanent solution must be found." He added that Senator Kennedy, Congressman Harrington and he were planning to introduce legislation authorizing funding for the long-term solution.

"I am hopeful that this legislation will pass the Congress early in the next funding," concluded the Massachusetts Senator.

##########

APPENDIX A

TOWN OF NEWBURY
Office of
TOWN CLERK
NEWBURY, MASS., 01950

Nov. 10, 1972

U. S. Army Corp. of Engineers N.E. Div.

424 Trapello Rd.

Waltham, Mass. 02154

Att: Col. Charles J. Ostemndorf

Dear Sir:

On Nov. 9, 1972 at 7.30 pm, a special Town meeting was held in the Town of Newbury. Article #11 of the Warrant read as follows:

To see if the Town will vote to appropriate the sum of $600.00 by transfer from available funds and to authorize the Selectmen to use said appropriation to acquire by gift, by purchase or take by eminent domain, under Chapter 79 of the General Laws of Massachusetts, the following described parcels of land to be used for the purpose of preventing erosion and for the health, safety and protection of the General Public, and to authorize and direct the Board of Selectmen of the Town of Newbury to apply for Federal assistance and for State financial assistance and to make agreements with the appropriate State and Federal Bureaus and to carry out the purposes contained in this Article, or take any other action thereon.

The lots to be acquired are shown on an attached sheet.

The Moderator ruled a 2/3 vote to accpet was necessary.

The vote was YES 98 NO 6. Moderator ruled that Article 11 Passed.

APPENDIX A

The parcels of land to be acquired by gift, by purchase or by eminent domain, are as follows:

PARCEL ONE Lot 79 Block F as shown on Assessors maps for the Town of Newbury, believed to be owned by Augustine J. Swift ET UX Jeannette B. and containing about 9,420 feet.

PARCEL TWO Lot 83 Block F as shown on Assessors maps for the Town of Newbury, believed to be owned by Augustine J. Swift ET UX Jeannette B. and containing about 9,420 feet.

PARCEL THREE Lot 85 Block F as shown on Assessors maps for the Town of Newbury, believed to be owned by John F. Stokes ET UX Margaret C. and containing about 10,580 feet.

PARCEL FOUR Lot 86 Block F as shown on Assessors maps for the Town of Newbury, believed to be owned by John F. Stokes ET UX Margaret C. and containing about 10,788 feet.

PARCEL FIVE Lot 90 Block F as shown on Assessors maps for the Town of Newbury, believed to be owned by John B. Fielding ET UX Gertrude & Sarah J. Hall. and containing about 9,118 feet.

PARCEL SIX Lot 91 Block F. as shown on Assessors maps for the Town of Newbury, believed to be owned by Olga Roche & Mary Kelleher and containing about 9,545 feet.

PARCEL SEVEN Lot 96 Block F. as shown on Assessors maps for the Town of Newbury, believed to be owned by Mariette Coffey and containing about 8,335 feet.

APPENDIX A

TOWN OF NEWBURY
Office of
TOWN CLERK
NEWBURY, MASS., 01950

#2 Corp of Army Eng. 11/10/72

The lots referred to are those that must be conveyed to Public ownership so that the Corp. of Engineers, or any other Public endity may apply sand or any other material to this beach front area for the purpose of stopping erosion by the ocean.

We wish to advise that the Selectmen are proceeding with the intent of the Article and would be glad to meet with any appropriate authority to expedite action necessary.

Yours very truly,

Richard H Knight

William L Pearl

James G Howe

Selectmen

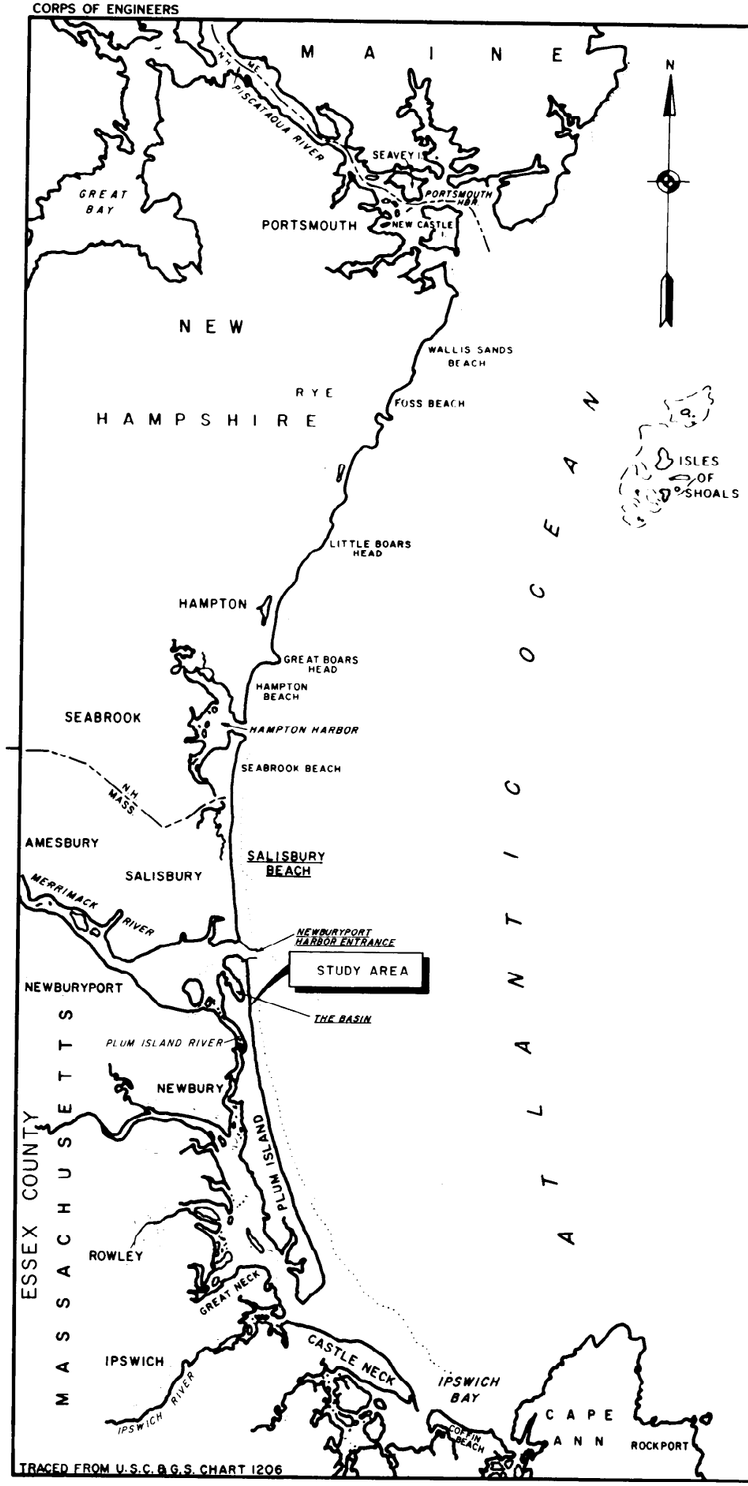
I hereby certify that the Town meeting was called according to By-Laws of the Town and that a quorm was present. Also that the vote as stated has been recorded in the records of the Town.

Ralph S Powell

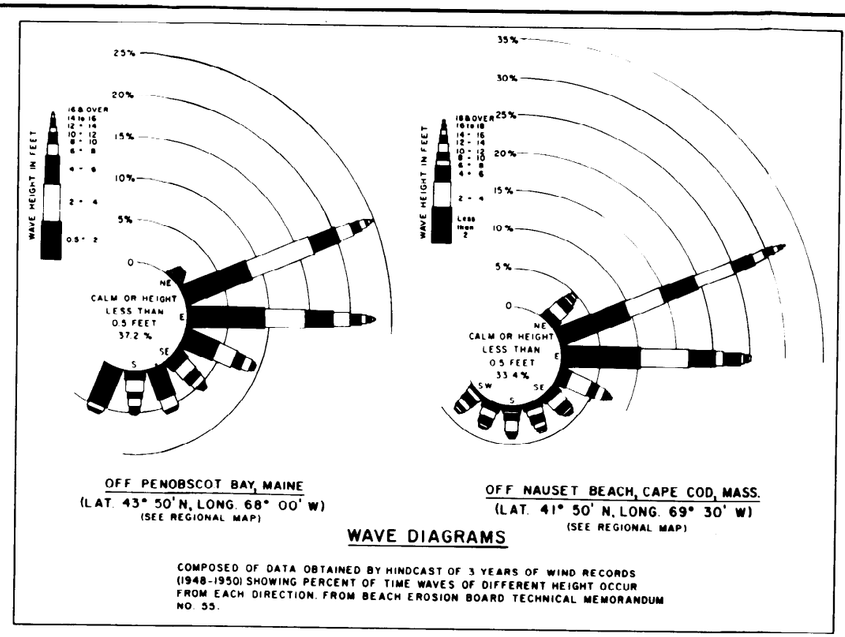
Town Clerk

CORPS OF ENGINEERS

U. S. ARMY

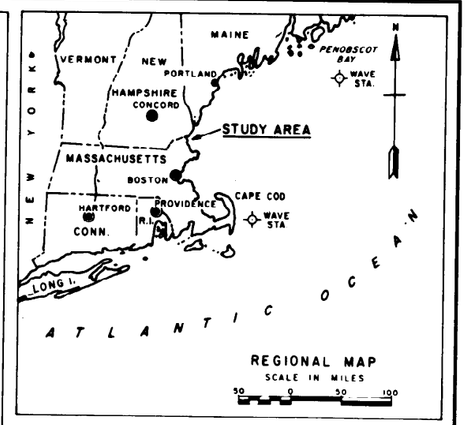


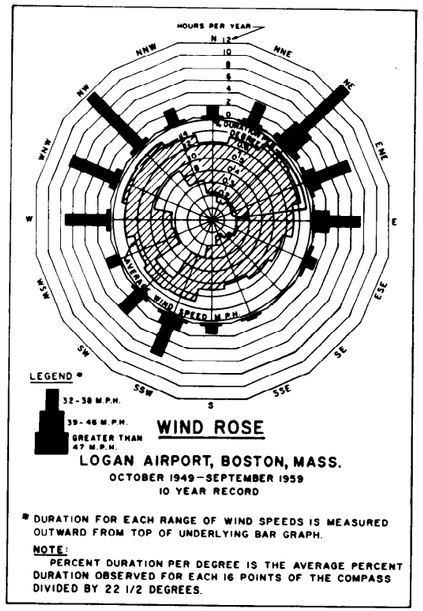
TRACED FROM U.S.C.&G.S. CHART 1206



WAVE DIAGRAMS

COMPOSED OF DATA OBTAINED BY HINDCAST OF 3 YEARS OF WIND RECORDS (1948-1950) SHOWING PERCENT OF TIME WAVES OF DIFFERENT HEIGHT OCCUR FROM EACH DIRECTION. FROM BEACH EROSION BOARD TECHNICAL MEMORANDUM NO. 55.





WIND ROSE

LOGAN AIRPORT, BOSTON, MASS.

OCTOBER 1949—SEPTEMBER 1959

10 YEAR RECORD

* DURATION FOR EACH RANGE OF WIND SPEEDS IS MEASURED OUTWARD FROM TOP OF UNDERLYING BAR GRAPH.

NOTE:
PERCENT DURATION PER DEGREE IS THE AVERAGE PERCENT DURATION OBSERVED FOR EACH 16 POINTS OF THE COMPASS DIVIDED BY 22 1/2 DEGREES.

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

DR. BY T.C.B.	TR. BY A.D.C.	CK. BY C.E.W

SUBMITTED: PROJECT ENGINEER

CHIEF, COASTAL DEVEL. SECT.

APPROVAL RECOMMENDED CHIEF, PLANNING BRANCH

APPROVED: CHIEF, ENGINEERING DIVISION

DATE JANUARY 1973

BEACH EROSION CONTROL STUDY OF PLUM ISLAND BEACH NEWBURY, MASSACHUSETTS LOCATION MAP

SCALE IN FEET
10000 0 10000 20000 30000

TO ACCOMPANY REPORT DATED: JANUARY 1973

SCALE: 1" = 1000'

DRAWING NUMBER B.E. Pm Id. 16

SHEET 1 OF 1

PLATE NO. 1

CORPS OF ENGINEERS

U. S. ARMY

E. 785,000

E. 786,000

E. 787,000

E. 788,000

N 658,000

N 657,000

N 656,000

N

PLUM ISLAND

ATLANTIC OCEAN

NORTHERN BLVD

PLUM ISL TNPKE

PROFILE 1

PROFILE 2

PROFILE 3

PROFILE 4

PROFILE 5

PROFILE 6

NOTES:

Soundings and elevations are in feet and tenths and are referred to the plane of Mean Low Water.

Shoreline is Mean High Water. Mean tide range is 8.3 feet. Buildings, streets, roads, beach profiles and Mean High Water Line are from survey of December 1972 by the Corps of Engineers.

Plane Coordinates are based on the Lambert Grid System for the Commonwealth of Massachusetts.

1972 Mean High Water Shown: ———

Profiles are shown: PROFILE 2

REVISION	DATE	DESCRIPTION	BY

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

DR. BY	TR. BY	CK. BY
R.D.B	R.D.B.	C.E.W

SUBMITTED:
PROJECT ENGINEER

CHIEF, COASTAL DEVEL. SECT.

CHIEF, PLAN FORMULATION SECT.

APPROVAL RECOMMENDED:
CHIEF, PLANNING BRANCH

APPROVED
CHIEF, ENGINEERING DIVISION

DATE JANUARY 1973

BEACH EROSION CONTROL STUDY OF PLUM ISLAND BEACH NEWBURY, MASSACHUSETTS SURVEY MAP

SCALE IN FEET

100' 0 100 200 300

TO ACCOMPANY REPORT
DATED: JANUARY 1973

SCALE 1"=100'

DRAWING NUMBER
B.E. Pm Id. 17

SHEET 1 OF 1

PLATE NO. 2

DISTANCE IN FEET

ELEVATIONS AND DEPTHS IN FEET REFERRED TO M.L.W.

PROFILE 1

PROFILE 2

PROFILE 3

PROFILE 4

PROFILE 5

PROFILE 6

HOUSE
SAND BAGS
SAND DUNE
BULKHEAD
M.H.W. El. 8.3
M.L.W. El. 0.0

LEGEND

1968 ——— Corps of Engrs.
1972 - - - - - Corps of Engrs.

NOTE

Top elevation of landward end of profiles is generally at the top of embankment or dune.

BEACH EROSION CONTROL STUDY OF
PLUM ISLAND BEACH
NEWBURY, MASSACHUSETTS
PROFILES

SHEET 1 OF 1 — SCALE IN FEET — JAN. 1973

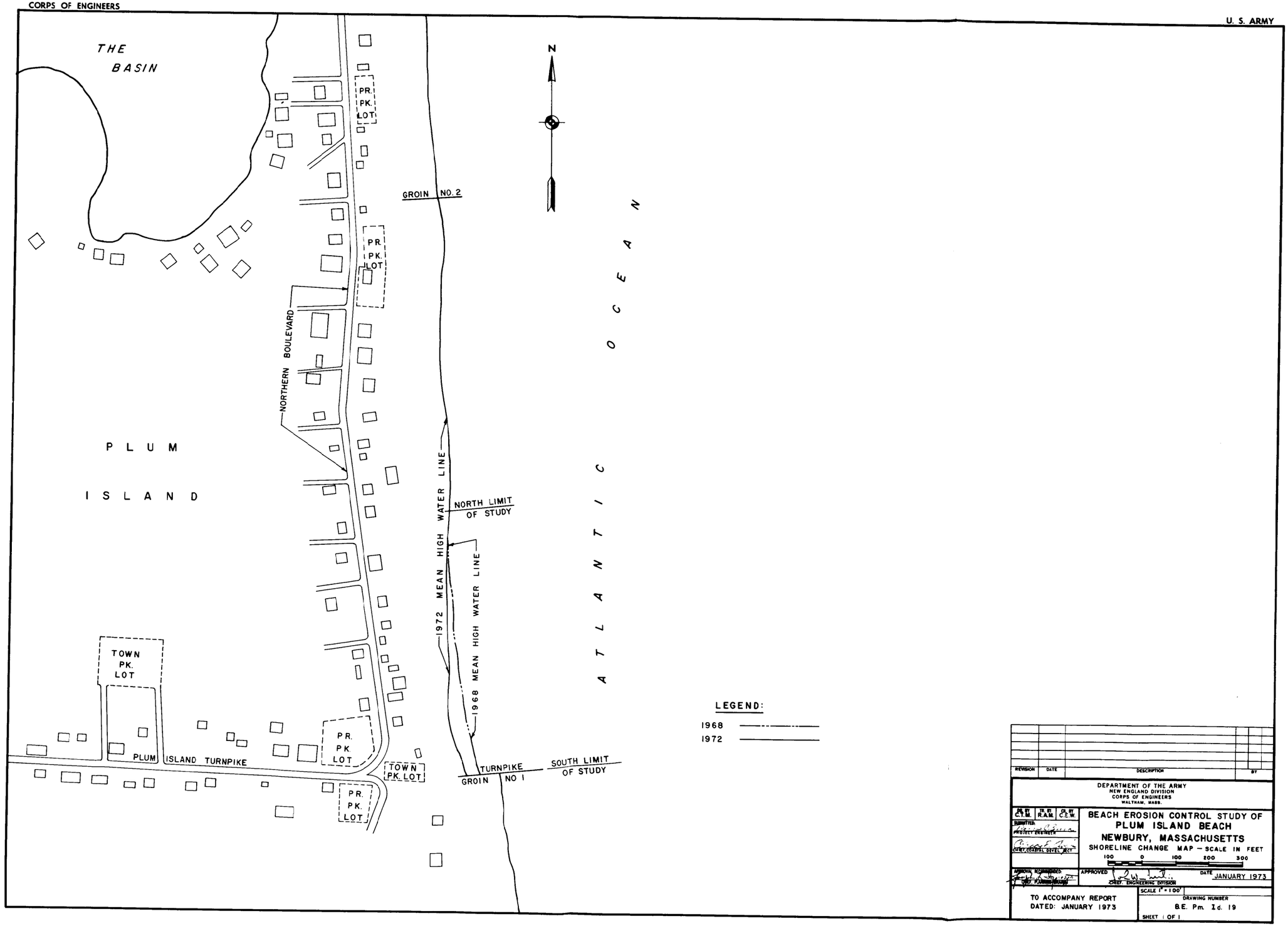
HOR. 200' 0 200' 400' 600'
VERT. 10' 0 10' 20' 30'

FILE NO. B.E. Pm. Id. 18

PLATE NO. 3

CORPS OF ENGINEERS

U. S. ARMY



REVISION	DATE	DESCRIPTION	BY

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

DR. BY C.T.M. | TR. BY R.A.M. | CH. BY C.E.W.

SUBMITTED: PROJECT ENGINEER

CHIEF, COASTAL DEVEL. BR'CH

BEACH EROSION CONTROL STUDY OF PLUM ISLAND BEACH NEWBURY, MASSACHUSETTS

SHORELINE CHANGE MAP — SCALE IN FEET

100 0 100 200 300

APPROVED: CHIEF, ENGINEERING DIVISION

DATE: JANUARY 1973

APPROVAL RECOMMENDED: CHIEF, PLANNING BRANCH

TO ACCOMPANY REPORT DATED: JANUARY 1973

SCALE 1" = 100'

DRAWING NUMBER: B.E. Pm. Id. 19

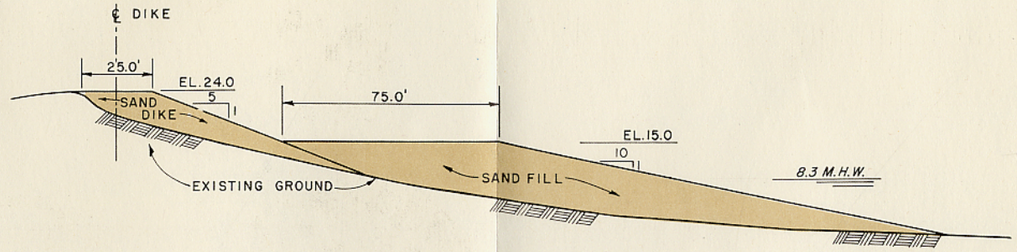
SHEET 1 OF 1

PLATE NO. 4

CORPS OF ENGINEERS — U. S ARMY

PLAN OF PROTECTION

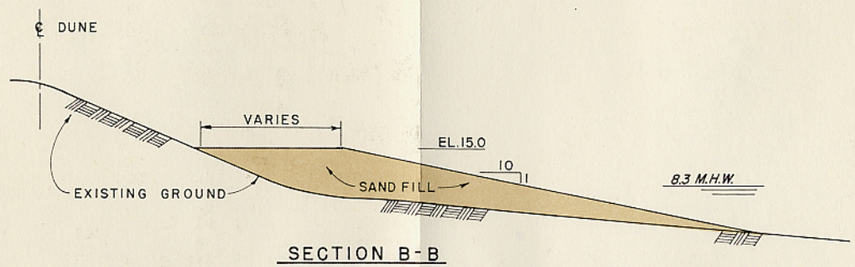
PROVIDE EMBANKMENT AND DUNE RESTORATION WITH BEACH WIDENING ALONG 800 FEET OF SHOREFRONT BY DIRECT PLACEMENT OF SAND FILL AND PERIODIC NOURISHMENT.



SECTION A-A

SCALE IN FEET

HORIZ. 20' 0 20' 40'
VERT. 10' 0 10' 20'



SECTION B-B

SCALE IN FEET

HORIZ. 20' 0 20' 40'
VERT. 10' 0 10' 20'

NOTES:

ELEVATIONS ARE IN FEET AND TENTHS AND ARE REFERRED TO THE PLANE OF MEAN LOW WATER.

SHORELINE IS MEAN HIGH WATER FROM 1968 AERIAL PHOTOGRAPH, TIDAL RANGE IS 8.3 FEET.

PROPOSED BEACH BERM WIDTH IS 75 FEET, AT EL. 15.0 FROM THE TURNPIKE GROIN NORTH FOR 420 FEET. BERM THEN VARIES FOR THE REMAINING NORTHERN 380 FEET TO BLEND INTO EXISTING GROUND AT EL. 15.0.

REVISION	DATE	DESCRIPTION	BY

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

DR. BY	TR. BY	CK. BY
J.G.D.	J.G.D.	C.E.W.

SUBMITTED: PROJECT ENGINEER
REVIEWED: CHIEF, COASTAL DEVPL. SECT.
APPROVAL RECOMMENDED: CHIEF, PLANNING DIVISION

BEACH EROSION CONTROL STUDY OF
PLUM ISLAND BEACH
NEWBURY, MASSACHUSETTS
PLAN OF PROTECTION - SCALE IN FEET
100 0 100 200 300

APPROVED: CHIEF, ENGINEERING DIVISION
DATE JANUARY 1973

TO ACCOMPANY REPORT
DATED: JANUARY 1973

SCALE 1" = 100'
DRAWING NUMBER
B.E. Pm. Id. 20
SHEET 1 OF 1

PLATE NO. 5